



Air Quality Assessment: Knowle Lane, Fair Oak, Eastleigh

January 2023



Experts in air quality
management & assessment

Document Control

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1 Introduction

- 1.1 This report assesses the potential air quality impacts on the proposed industrial development off Knowle Lane in Fair Oak. The proposals are for the construction of a number of two-storey general industrial (B2) units. The proposed development lies adjacent to the Fair Oak landfill operated by SUEZ.
- 1.2 The proposed development will generate additional traffic on the local road network. Environmental Protection UK (EPUK) and the Institute of Air Quality Management (IAQM)¹ have developed an approach to determine whether emissions from road traffic generated by a development have the potential for significant air quality effects. Where a development is located outside of an Air Quality Management Area (AQMA) the effects can be screened as insignificant if the development will generate fewer than 500 Light Duty Vehicle (LDV) and 100 Heavy Duty Vehicle (HDV) movements. It is considered unlikely that the proposed development will exceed the screening criteria; the effect from road traffic emissions on local air quality is considered not significant, and not considered further within this report.
- 1.3 This report presents an assessment of the impact of nitrogen dioxide (NO₂) emissions from the landfill gas engine and flare on the proposed development. It also assesses the impacts of a range of trace gases emitted both fugitively from the surface of the capped landfill and from the stack of the landfill engine and flare. The assessment utilises landfill gas composition data provided by SUEZ for the Fair Oak landfill site, stack emissions monitoring reports for the landfill gas engine and flare, the landfill gas engine product datasheet and emission standards for capped landfills provided in Environment Agency (EA) guidance.
- 1.4 The location of the proposed development is shown in Figure 1, along with the adjacent Fair Oak landfill boundary.

¹ The IAQM is the professional body for air quality practitioners in the UK.

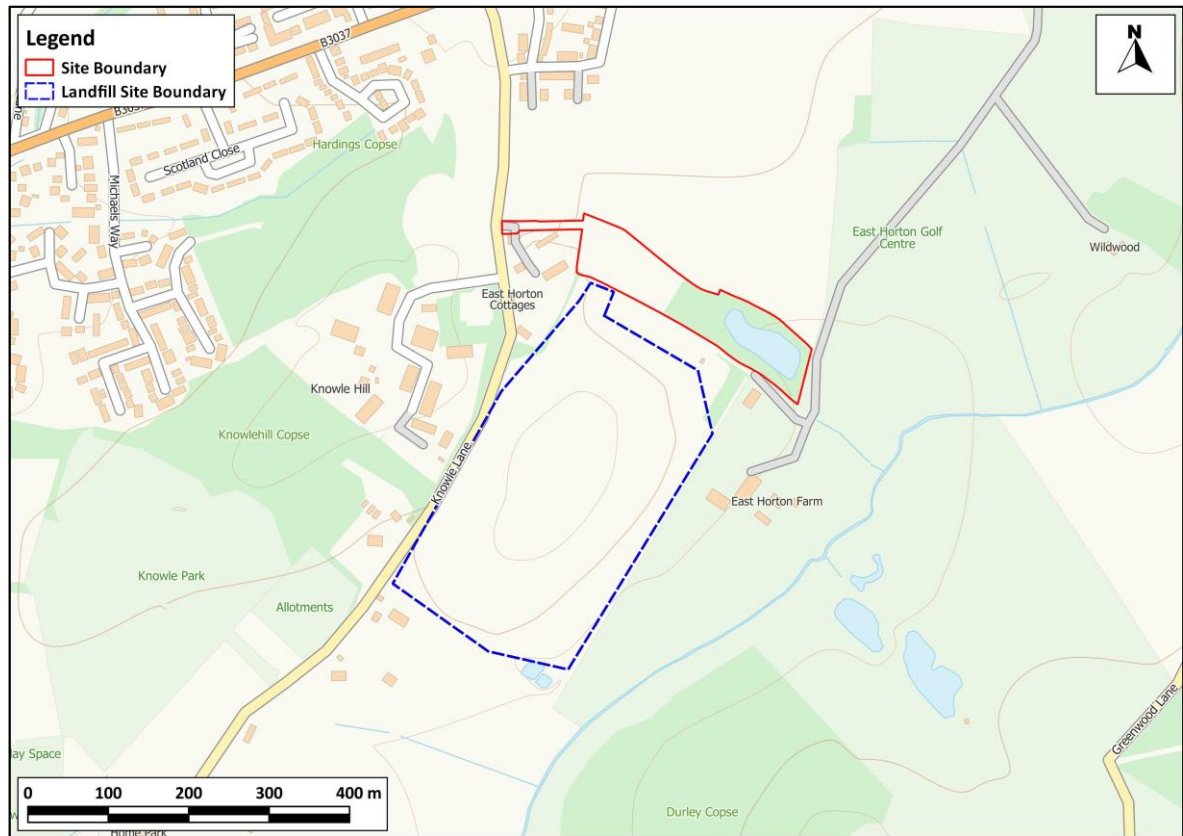


Figure 1: Location of Proposed Development

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2 Policy Context

- 2.1 All European legislation referred to in this report is written into UK law and remains in place.

Air Quality Strategy

- 2.2 The Air Quality Strategy (Defra, 2007) published by the Department for Environment, Food, and Rural Affairs (Defra) and Devolved Administrations, provides the policy framework for air quality management and assessment in the UK. It provides air quality standards and objectives for key air pollutants, which are designed to protect human health and the environment. It also sets out how the different sectors: industry, transport and local government, can contribute to achieving the air quality objectives. Local authorities are seen to play a particularly important role. The strategy describes the Local Air Quality Management (LAQM) regime that has been established, whereby every authority has to carry out regular reviews and assessments of air quality in its area to identify whether the objectives have been, or will be, achieved at relevant locations, by the applicable date. If this is not the case, the authority must declare an AQMA, and prepare an action plan which identifies appropriate measures that will be introduced in pursuit of the objectives.

The Environmental Permitting (England and Wales) Regulations 2016, as Amended

- 2.3 Management of landfill gas at Fair Oak landfill is regulated by the EA under a permit issued under the Environmental Permitting (England and Wales) Regulations 2016, as amended (The Environmental Permitting (England and Wales) Regulations 2016 No. 1154, 2016). The Regulations aim to protect human health and the environment by reducing harmful emissions, in particular through application of Best Available Techniques (BAT) and through the imposition of emission limit values.
- 2.4 To comply with the Environmental Permit, SUEZ are required to periodically monitor both stack and surface emissions, and these emissions must meet the defined standards in the permit and in the EA's Landfill Technical Guidance Notes.

Clean Air Strategy 2019

- 2.5 The Clean Air Strategy (Defra, 2019) sets out a wide range of actions by which the UK Government will seek to reduce pollutant emissions and improve air quality. Actions are targeted at four main sources of emissions: Transport, Domestic, Farming and Industry. At this stage, there is no straightforward way to take account of the expected future benefits to air quality within this assessment.

Environment Act 2021

- 2.6 The UK's new legal framework for protection of the natural environment, the Environment Act (2021) passed into UK law in November 2021. The Act gives the Government the power to set long-term, legally binding environmental targets. It also establishes an Office for Environmental Protection (OEP), responsible for holding the Government to account and ensuring compliance with these targets.

Planning Policy

National Policies

- 2.7 The National Planning Policy Framework (NPPF) (2021) sets out planning policy for England. It states that the purpose of the planning system is to contribute to the achievement of sustainable development, and that the planning system has three overarching objectives, one of which (Paragraph 8c) is an environmental objective:

"to protect and enhance our natural, built and historic environment; including making effective use of land, improving biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy".

- 2.8 To prevent unacceptable risks from air pollution, Paragraph 174 of the NPPF states that:

"Planning policies and decisions should contribute to and enhance the natural and local environment by...preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air quality".

- 2.9 Paragraph 185 states:

"Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development".

- 2.10 More specifically, on air quality, Paragraph 186 makes clear that:

"Planning policies and decisions should sustain and contribute towards compliance with relevant limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and Clean Air Zones, and the cumulative impacts from individual sites in local areas. Opportunities to improve air quality or mitigate impacts should be identified, such as through traffic and travel management, and green infrastructure provision and enhancement. So far as possible these opportunities should be considered at the plan-making stage, to ensure a strategic

approach and limit the need for issues to be reconsidered when determining individual applications. Planning decisions should ensure that any new development in Air Quality Management Areas and Clean Air Zones is consistent with the local air quality action plan”.

- 2.11 The NPPF is supported by Planning Practice Guidance (PPG) (Ministry of Housing, Communities & Local Government, 2019), which includes guiding principles on how planning can take account of the impacts of new development on air quality. The PPG states that:

“Defra carries out an annual national assessment of air quality using modelling and monitoring to determine compliance with Limit Values. It is important that the potential impact of new development on air quality is taken into account where the national assessment indicates that relevant limits have been exceeded or are near the limit, or where the need for emissions reductions has been identified”.

- 2.12 Regarding plan-making, the PPG states:

“It is important to take into account air quality management areas, Clean Air Zones and other areas including sensitive habitats or designated sites of importance for biodiversity where there could be specific requirements or limitations on new development because of air quality”.

- 2.13 The role of the local authorities through the LAQM regime is covered, with the PPG stating that a local authority Air Quality Action Plan *“identifies measures that will be introduced in pursuit of the objectives and can have implications for planning”.*

- 2.14 Regarding the need for an air quality assessment, the PPG states that:

“Whether air quality is relevant to a planning decision will depend on the proposed development and its location. Concerns could arise if the development is likely to have an adverse effect on air quality in areas where it is already known to be poor, particularly if it could affect the implementation of air quality strategies and action plans and/or breach legal obligations (including those relating to the conservation of habitats and species). Air quality may also be a material consideration if the proposed development would be particularly sensitive to poor air quality in its vicinity”.

- 2.15 The PPG sets out the information that may be required in an air quality assessment, making clear that:

“Assessments need to be proportionate to the nature and scale of development proposed and the potential impacts (taking into account existing air quality conditions), and because of this are likely to be locationally specific”.

- 2.16 The PPG also provides guidance on options for mitigating air quality impacts, as well as examples of the types of measures to be considered. It makes clear that:

“Mitigation options will need to be locationally specific, will depend on the proposed development and need to be proportionate to the likely impact. It is important that local planning authorities work

with applicants to consider appropriate mitigation so as to ensure new development is appropriate for its location and unacceptable risks are prevented”.

Local Policies

2.17 Eastleigh Borough Council (EBC) adopted its new Local Plan, which covers the period 2016-2036, in April 2022 (Eastleigh Borough Council, 2022). The Local Plan identifies air quality within Issue G9 and includes Policy DM8, ‘Pollution’ that states:

1. *“Development will not be permitted if it is likely to cause loss of amenity or impact on public health or other unacceptable environmental impacts through:*
 - a. *air pollution (including odours or particulate emissions);*
 - b. *pollution of surface, underground, coastal waters or other watercourses;*
 - c. *noise or vibration;*
 - d. *light intrusion, both generally and with respect to the South Downs National Park’s status as an International Dark Night Skies reserve; or*
 - e. *land contamination.*
2. *Development susceptible to particular forms of pollution will not be permitted: a. where it will be adversely affected by such pollution, unless measures can be taken that adequately mitigate the polluting effects; or b. where it would inhibit existing economic or other activities giving rise to acceptable polluting effects.*
3. *Where a development site is known or suspected to be contaminated, before the site is developed the Borough Council will require the contamination to be remediated to a standard where, as a minimum, it cannot be defined as ‘contaminated land’ under Part IIA of the Environmental Protection Act 1990.”*

Guidance

Guidance for Monitoring Trace Components in Landfill Gas LFTGN04

2.18 The EA has published guidance (Environment Agency, 2010a) which describes 29 priority trace components to monitor in landfill gas, along with their recommended sampling and analytical methods. Of these, 18 are identified due to their potential health effects. Under conditions in the environmental permit for Fair Oak landfill, SUEZ is required to periodically sample and quantify the concentrations of these priority trace species in the landfill gas. Landfill gas composition data from Fair Oak landfill have been provided by SUEZ (Appendix A1) and used to estimate surface and point source emissions.

Guidance on Monitoring Landfill Gas Surface Emissions LFTGN07

- 2.19 The EA has published guidance (Environment Agency, 2010b) which sets out the method and frequency for monitoring of surface emissions from landfills, and the methane surface emission standards that should be met. For permanently capped landfills, as is the case for Fair Oak landfill, the average methane flux measured at an array of several points should be no higher than 0.001 mg/m²/s. This emission standard has been used, along with landfill gas composition data from SUEZ (Appendix A1), to estimate surface emissions of the trace components.

Air Emissions Risk Assessment for your Environmental Permit

- 2.20 The EA has published guidance (Environment Agency, 2023a) which provides the procedure for evaluating the environmental risk of emissions to air from permitted processes. The guidance provides a procedure for calculating the impact of emissions, and standards that should be met. These standards include statutory Ambient Air Directive (AAD) Limit Values, Air Quality Objectives (AQOs) and non-statutory guideline values known as Environmental Assessment Levels (EALs).

3 Assessment Criteria

Relevant Exposure

- 3.1 The Government has established a set of air quality standards and AQOs to protect human health. The 'standards' are set as concentrations below which effects are unlikely even in sensitive population groups, or below which risks to public health would be exceedingly small. They are based purely upon the scientific and medical evidence of the effects of an individual pollutant. The AQOs set out the extent to which the Government expects the standards to be achieved by a certain date. They take account of economic efficiency, practicability, technical feasibility and timescale. The objectives for use by local authorities are prescribed within the Air Quality (England) Regulations (2000) and the Air Quality (England) (Amendment) Regulations (2002).
- 3.2 The AQOs apply at locations where members of the public are likely to be regularly present and are likely to be exposed over the averaging period of the objective. Defra explains where these objectives will apply in its Local Air Quality Management Technical Guidance (Defra, 2022). The annual mean AQOs are considered to apply at the façades of residential properties, schools, hospitals etc.; they do not apply at hotels. The 1-hour mean AQOs apply wherever members of the public might regularly spend 1-hour or more, including outdoor eating locations and pavements of busy shopping streets. They do not apply at places of work and thus are not strictly relevant for this assessment.
- 3.3 EALs derived by the Environment Agency are only applicable to members of the general public and assume exposure can occur up to 52 weeks of the year. Consequently, they are not applicable to industrial workplace locations where exposure would most likely be limited to 8 hours per day, 5 days a week. Furthermore, the EALs are derived for the most sensitive members of the general population, such as children, the elderly or those with severe respiratory conditions and, consequently, include additional 'safety factors' which are not relevant to an adult workforce who are typically between the ages of 16 – 65 and free from health conditions that would compromise their ability to work.
- 3.4 Under the REACH regulations, Derived No Effect Levels (DNELs) for workforce exposure and, additionally, for the general population, are required to be established in Chemical Safety Report dossiers registered with the European Chemicals Agency (ECHA). It is the DNELs for workplace exposure that would be more appropriate for the assessment of impact at the proposed development.
- 3.5 However, although AQOs, EALs and DNELs for general population exposure are not relevant for assessing exposure at the proposed development, they have nonetheless been considered in this assessment as a conservative measure.

Nitrogen Dioxide

- 3.6 The UK-wide AQOs for nitrogen dioxide were to have been achieved by 2005 and continue to apply in all future years thereafter.
- 3.7 European Union (EU) Directive 2008/50/EC (The European Parliament and the Council of the European Union, 2008) sets limit values for nitrogen dioxide and is implemented in UK law through the Air Quality Standards Regulations (2010)². The limit value for nitrogen dioxide is the same numerical concentration as the UK AQO. Achievement of the limit values is a national obligation rather than a local one. In the UK, only monitoring and modelling carried out by UK Central Government meets the specification required to assess compliance with the limit values. Central Government does not normally recognise local authority monitoring or local modelling studies when determining the likelihood of the limit values being exceeded, unless such studies have been audited and approved by Defra and Department for Transport's Joint Air Quality Unit (JAQU).
- 3.8 The nitrogen dioxide AQOs utilised in this assessment are provided in Table 1.

Table 1: Air Quality Criteria for Nitrogen Dioxide

Pollutant	Time Period	Assessment Level (AQO)
Nitrogen Dioxide	1-hour Mean	200 µg/m ³ not to be exceeded more than 18 times a year
	Annual Mean	40 µg/m ³

Trace Gases from Landfill

- 3.9 The assessment criteria as defined by the EA's air emissions risk assessment for your environmental permit guidance are provided in Table 2. Table 2 also includes the main potential effect of each compound, i.e., health or odour, referenced in LFTGN04. Whilst 11 of the compounds are only listed as having an odour effect, these compounds have also been assessed for their potential effects on human health where health-based metrics are available.
- 3.10 Where an AAQ Limit Value, AQO, or EAL is not defined for a particular component, DNELs for population exposure as defined in Chemical Safety Reports submitted under the REACH regulations have been used in accordance with the EA's guidance.
- 3.11 In the absence of any assessment criteria in the EA's guidance, REACH DNELs, or other toxicological data, WELs or PELs from the Health and Safety Executive (HSE, 2020) or Occupational Safety and Health Administration (OSHA) have been used. These have been converted to 1-hour mean EALs by applying a factor of 10 reduction factor to 15-minute mean short-term exposure levels, and converted to annual mean EALs by applying a factor of 100 reduction factor to 8-hour time-weighted average (TWA) values per previous guidance provided by the EA.

² As amended through The Air Quality Standards (Amendment) Regulations 2016 and The Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020.

Table 2: Assessment Criteria

Pollutant	Assessment Criteria ($\mu\text{g}/\text{m}^3$)		Main Potential Effect (LFTGN04)	Comments
	Annual Mean	1-hour Mean		
Arsenic (as As)	0.006	-	Health	AAD
Acetaldehyde (Ethanal)	370	9,200	Odour	EAL
Formaldehyde (Methanal)	5	100	Health	EAL
Vinyl chloride (or Chloroethylene)	10	1,300 ^a	Health	EAL
1,3-butadiene	2.25	-	Health	UK AQO
Methanethiol	760	-	Odour	REACH DNEL
Chloroethane	6,700	No Hazard Identified ^b	Health	REACH DNEL
1-pentene	No Hazard Identified ^b		Odour	REACH DNEL
1,4-epoxy-1,3-butadiene (Furan)	No toxicological summary available		Health	No toxicological summary available
Ethanethiol	1,960	No Hazard Identified ^b	Odour	REACH DNEL
1,1-dichloroethene	32	No Threshold Derived ^b	Health	REACH DNEL
Dimethyl sulphide	2,170	No Hazard Identified ^b	Odour	REACH DNEL
Dichloromethane	44,000	No Hazard Identified ^b	Odour	REACH DNEL
Carbon disulphide	1,880	No Hazard Identified ^b	Odour and Health	REACH DNEL
1,2-dichloroethene	198,000	No Threshold Derived ^b	Health	REACH DNEL
1,1-dichloroethane	4,000	-	Health	No toxicological summary available. Derived from OSHA PEL
Propanethiol ^c	1,310	No Hazard Identified ^b	Odour	REACH DNEL
1,2-dichloroethane	3	-	Health	EAL
Carbon tetrachloride	130	3,900	Health	EAL
Benzene	5	30 ^a	Health	AAD / UK AQO / EAL
Trichloroethene	2	-	Health	EAL

Pollutant	Assessment Criteria ($\mu\text{g}/\text{m}^3$)		Main Potential Effect (LFTGN04)	Comments
	Annual Mean	1-hour Mean		
Butanethiol	15	-	Odour	No toxicological summary available. Derived from OSHA PEL.
Dimethyl disulphide	380	3,800	Odour	REACH DNEL
Toluene	1,910	8,000	Health	EAL
Butyric acid	9,150	No Hazard Identified ^b	Odour	REACH DNEL
Ethyl butyrate	7,400	No Threshold Derived ^b	Odour	REACH DNEL
2-Butoxyethanol	59,000	426,000	Health	REACH DNEL
Styrene	800	800	Health	EAL
Hydrogen sulphide	140	150	Health and Odour	EAL

^a 24-hour mean

^b As reported in REACH chemical safety reports

^c Propanethiol can exist as two isomers; they have the same chemical formula but different structure and, as a result, can have different health effects. The assessment criteria for propane-2-thiol have been used in this assessment as they are lower, and therefore provide a conservative assessment.

4 Assessment Approach

Overview

- 4.1 Fair Oak landfill is a closed, permanently capped, and restored landfill, last accepting waste in 2009. Landfill gas continues to be produced from the anaerobic decomposition of waste beneath the surface and is managed by SUEZ under the landfill's environmental permit.
- 4.2 Although a permanent cap is in place, no cap and landfill gas management infrastructure is 100% effective at capturing all landfill gas generated, and residual amounts may be emitted through the surface and from specific point features such as gas well seals. Unburnt components of landfill gas may also be emitted from the landfill gas utilisation plant through inefficiencies in the combustion process.
- 4.3 SUEZ, who operates the Fair Oak landfill, has advised that a Jenbacher J312 gas engine and Uniflare flare (750 m³/hr) were recently installed at the site to support the management of landfill gas. Further details of the engine and flare are provided in Appendix A1. All operations at the site are controlled by an Environmental Permit issued by the EA to control emissions (including the landfill gas engine and flare) as required by the Landfill Directive (Council of the European Union, 1999), as implemented by the England and Wales by the Environmental Permitting (England and Wales) Regulations.
- 4.4 SUEZ has confirmed that the gas engine and flare are unlikely to ever operate simultaneously. They have also confirmed that there are no occasions when the landfill gases are vented unburnt.
- 4.5 Under the conditions of the landfill's environmental permit, SUEZ are required to perform periodic walkovers to measure the near surface concentration of methane to ascertain the efficacy of the cap and landfill gas management system. SUEZ has shared data from its walkover survey in 2020 which indicated low concentrations (1 – 2 ppm) of methane across the entire landfill surface. Furthermore, monitoring around 11 of 12 point features (gas wells) also indicated low concentrations of methane (1 – 2 ppm). At one gas well, a monitored value of 689 ppm was obtained which was identified as resulting from a defective seal. SUEZ has confirmed remedial work has since taken place to replace the seal and concentrations around the well have returned to values observed around all other wells. This evidence indicates that, overall, the capping and landfill gas management systems are effective at capturing the landfill gas generated. The walkover data are included in Appendix A3.
- 4.6 In addition to the site walkovers, SUEZ also periodically collects samples of landfill gas for quantitation of bulk (i.e., methane, carbon dioxide) gases and the trace components specified in LFTGN04, and periodically monitors stack emissions from the landfill gas engine and flare. These data have been used, together with the surface emission standard for permanently capped landfills in LFTGN07, to estimate fugitive emission rates from the surface and from the landfill gas engine

and flare, with the resultant prediction of the ambient concentrations of these components made using dispersion modelling.

Baseline Conditions

- 4.7 Aside from the landfill site itself, the emissions from which have been modelled explicitly, the proposed development is located away from any major sources of air pollution (such as industrial facilities and busy roads). As such, baseline concentrations of all pollutants considered within this assessment are considered to be approaching background concentrations.

Nitrogen Dioxide

- 4.8 Background concentrations of nitrogen dioxide have been defined using Defra's 2018-based background maps (Defra, 2023). These cover the whole of the UK on a 1 x 1 km grid. The background nitrogen dioxide maps for 2019 have been calibrated against concurrent measurements from national monitoring sites (AQC, 2020). The calibration factor calculated has also been applied to the future year 2023 backgrounds. The estimated annual mean background nitrogen dioxide concentration at the proposed development is 11.7 $\mu\text{g}/\text{m}^3$.
- 4.9 Following EA guidance (2023a), baseline short-term (1-hour mean) concentrations of nitrogen dioxide are assumed to be twice the annual mean concentration, equivalent to 23.3 $\mu\text{g}/\text{m}^3$, based on unrounded numbers.

Trace Gases from Landfill

- 4.10 Monitoring of the trace gases from landfill is not carried out in the local area. Nonetheless, the Fair Oak facility is likely to be the primary source of the trace gas emissions to air in the local area and would likely account for the majority of any baseline monitoring obtained. Consequently, in the first instance the impacts of emissions have been determined based on their predicted Process Contributions (PCs) alone. Where the PCs cannot be screened out, likely baseline values have been considered.

Modelling Methodology

- 4.11 Modelling has been carried out in line with the EA's 'Air emissions risk assessment for your environmental permit' guidance (Environment Agency, 2023a) and 'Environmental permitting: air dispersion modelling reports' guidance (Environment Agency, 2023b).
- 4.12 The contribution of emissions from the landfill gas engine and flare, as well as surface emissions, have been predicted for each of the priority trace components of landfill gas referenced in LFTGN04, as well as nitrogen dioxide from the combustion of gas, using the ADMS-5.2 dispersion model.
- 4.13 ADMS-5.2 is a next generation model that incorporates a state-of-the-art understanding of the dispersion processes within the atmospheric boundary layer. The model input parameters, including

the derivation of surface and point source emission rates of trace gas components, are set out in Appendix A2. The predicted contributions have then been compared to the identified assessment criteria in Table 1 and Table 2.

Operating Hours

- 4.14 It is not known precisely when or for how long the landfill gas engine and flare will operate as this is dependent on the rate of landfill gas production. The air quality modelling has therefore been carried out using the worst-case assumptions that:
- the landfill engine will operate for 100% of the year; and
 - the flare will operate for 100% of the year.
- 4.15 This will have significantly over-estimated the emissions and thus provides a worst-case scenario, as SUEZ has confirmed that the gas engine and flare are unlikely to ever be operated simultaneously.
- 4.16 For surface emissions, constant emissions have been assumed at ambient conditions, which utilises the ambient temperature taken from the meteorological data input to define the release temperature for the modelled area source.

Receptors

- 4.17 The contribution of landfill gas engine and flare, as well as surface, emissions have been predicted for a grid of receptors encompassing the proposed development site. The grid has a spacing of 7 m x 7 m, and extends at least 250 m beyond the proposed industrial units in each direction.
- 4.18 The receptor grid has been modelled at heights of 1.5 m and 4.5 m, representing ground and first floor level exposure, respectively.

Meteorological Data

- 4.19 In order to allow for uncertainties in local and future-year meteorological conditions, the dispersion model has been run five times, with each run using a different full year of hour-by-hour meteorological data from an appropriate meteorological station.
- 4.20 For each individual receptor point, the maximum predicted concentration across any of the five meteorological datasets has been determined. It is these maxima which are presented in this report.
- 4.21 This approach provides a degree of conservatism and will tend to over-predict the impacts of the landfill gas facility. Further details of this approach, as well as the meteorological datasets used, are provided in Appendix A2.

Buildings

- 4.22 Where buildings are a significant height relative to the stack height, building downwash effects may occur. The downwash effects should be accounted for within modelling where the stack is less than 2.5 times the height of the buildings within a distance which is five times the minimum of the stack height and the maximum projected width of the building.
- 4.23 For each meteorological year the model has been run with the proposed industrial units included, each with a height of 7.5 m. Further details of the modelled buildings are provided in Appendix A2.

Uncertainty

- 4.24 The point source dispersion model used in the assessment is dependent upon emission rates, flow rates, exhaust temperatures and other parameters for each source, all of which in reality are variable. There are then additional uncertainties, as models are required to simplify real-world conditions into a series of algorithms. These uncertainties cannot be easily quantified and it is not possible to verify the point-source model outputs. Sensitivity tests have also been applied to address uncertainties in future meteorological conditions to ensure a worst-case assessment.
- 4.25 On balance, when taking into account the assumed number of operating hours, meteorological conditions and building downwash, and the use of a maximum theoretical permitted surface emission flux rate based on the emission standard in LFTGN07, the assessment can be expected to over-predict the impacts of the landfill operations. The approach used thus provides a robust assessment.

5 Impact Assessment

Nitrogen Dioxide

- 5.1 The maximum predicted nitrogen dioxide contribution at any receptor within the proposed development site boundary, at both heights assessed, as extracted from the modelled grid data, is presented in Table 4. At all other receptors within the development site boundary predicted PCs are less than those presented in the table.

Table 3: Maximum Predicted Nitrogen Dioxide Process Contributions

Height (m)	Maximum Process Contribution ($\mu\text{g}/\text{m}^3$)		Assessment Criteria ($\mu\text{g}/\text{m}^3$)		% of Assessment Criteria	
	Annual Mean	1-hour Mean	Annual Mean	1-hour Mean	Annual Mean	1-hour Mean
1.5	4.8	34.5	40	200	12.1	17.3
4.5	9.0	46.7			22.4	23.4

- 5.2 Figure 2 shows a contour plot of the predicted total annual mean nitrogen dioxide concentrations across the application site at first floor level (4.5 m). The total annual mean nitrogen dioxide concentrations have been calculated by adding the local background concentration for 2023 to the modelled process contribution from both the landfill engine and flare. The predicted concentrations are well below the annual mean assessment level, and below $21 \mu\text{g}/\text{m}^3$ within the proposed development site boundary. Whilst not shown, predicted concentrations at ground level (1.5 m) are below $17 \mu\text{g}/\text{m}^3$ throughout the site.
- 5.3 Figure 3 shows a contour plot of the predicted 99.79th percentile of 1-hour mean nitrogen dioxide concentrations across the application site at first floor level (4.5 m). The total 99.79th percentile of 1-hour mean nitrogen dioxide concentrations have been calculated by adding twice the local background concentration for 2023 to the modelled process contribution from both the landfill engine and flare. The predicted concentrations are well below the 1-hour mean assessment level, and below $70 \mu\text{g}/\text{m}^3$ within the proposed development site boundary. Whilst not shown, predicted concentrations at ground level (1.5 m) are below $58 \mu\text{g}/\text{m}^3$ throughout the site.
- 5.4 As discussed in Paragraph 4.14, the contributions to nitrogen dioxide concentrations from the landfill gas engine and flare are based on continuous operation of both plant and therefore the concentrations are likely to be significantly overpredicted.
- 5.5 Predicted concentrations at the site are well below the assessment levels, thus air quality conditions are acceptable for the proposed industrial uses.

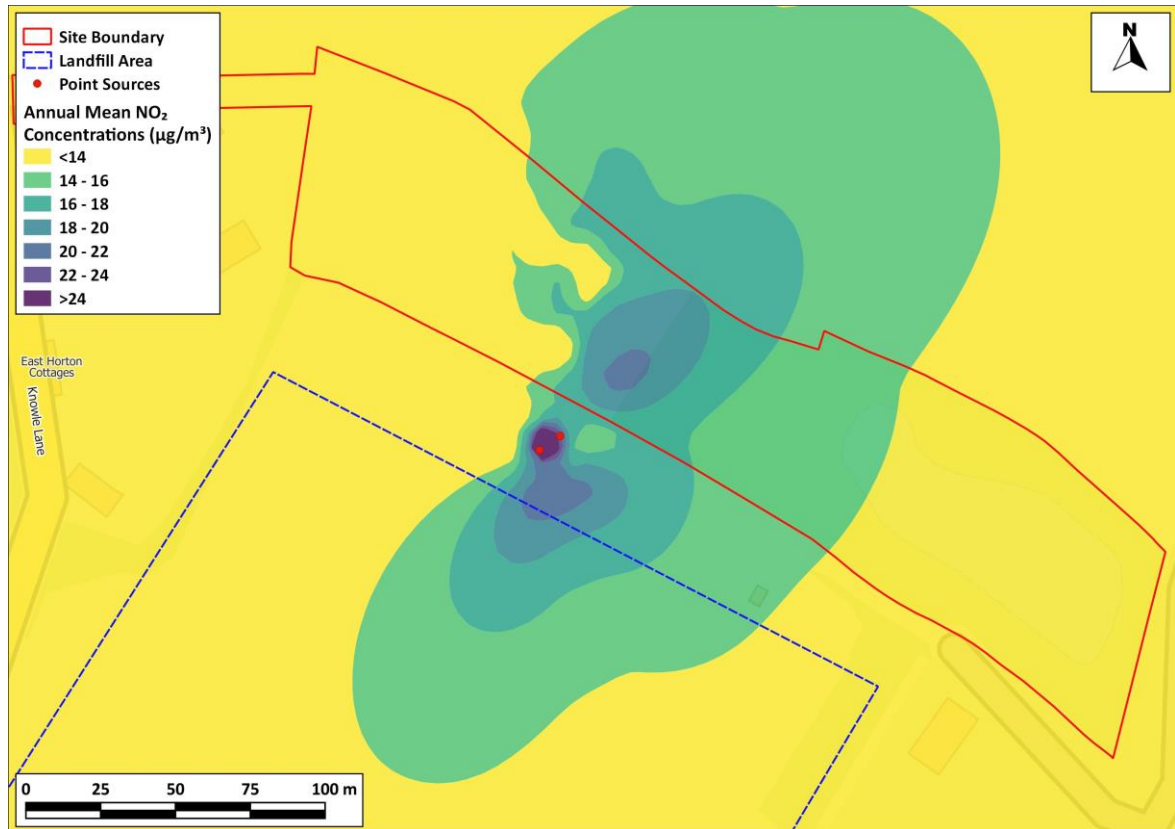


Figure 2: Total Annual Mean Nitrogen Dioxide Concentration Contours at 4.5 m (µg/m³)

Imagery ©2023 Getmapping plc, Infoterra Ltd & Bluesky, Maxar Technologies, Map data ©2023

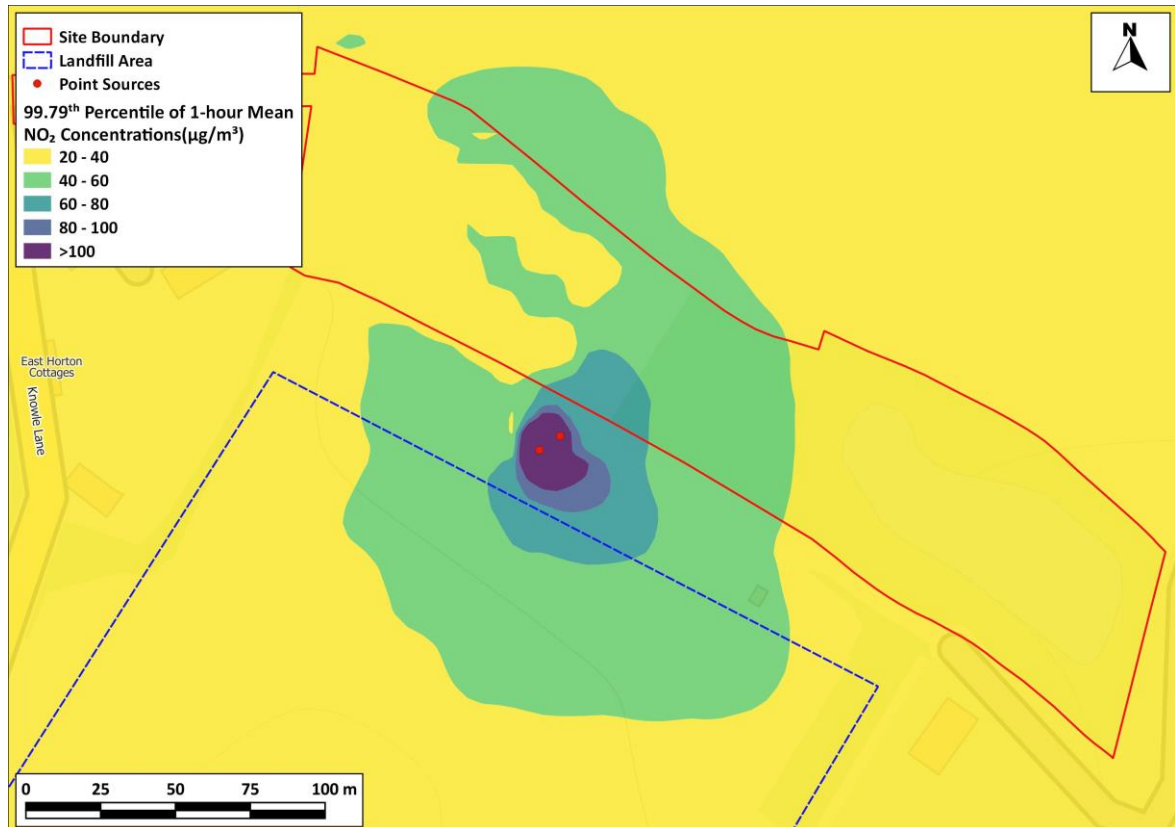


Figure 3: Total 99.79th Percentile of 1-hour Mean Nitrogen Dioxide Concentration Contours at 4.5 m ($\mu\text{g}/\text{m}^3$)

Imagery ©2023 Getmapping plc, Infoterra Ltd & Bluesky, Maxar Technologies, Map data ©2023

Trace Gases from Landfill

- 5.6 The EA's guidance (2023a) states that PCs can be considered insignificant where they are less than:
- 10% of a short-term environmental standard; or
 - 1% of a long-term environmental standard.
- 5.7 This is the case regardless of the total concentration (i.e. the PC + the local baseline, or the Predicted Environmental Concentration 'PEC').
- 5.8 Where these criteria are not met following detailed modelling, the EA does not provide any specific assessment criteria but instead requires a judgement of significance based on the site-specific circumstances, taking into account the PCs and PECs. EA guidance (2023a) does, however, provide a further screening criterion for long-term PECs, suggesting that where the long-term PEC is less than 70% of the long-term environmental standard, no further assessment is required.
- 5.9 The maximum predicted contribution at any receptor within the proposed development site boundary, at any height, as extracted from the modelled grid data, is presented in Table 4. For

annual mean concentrations, this location corresponds to a receptor 30 m northeast of the gas engine and flare stacks in the centre of the proposed development site, at a height of 4.5 m. For 1-hour mean concentrations, the location of the maxima occurs in the northwest corner of the proposed development site, 115 m from the stacks, at a height of 1.5 m. All other receptors within the development site boundary have predicted process contributions less than those quoted in the table.

Table 4: Maximum Predicted Process Contributions

Pollutant	Maximum Process Contribution ($\mu\text{g}/\text{m}^3$)		Assessment Criteria ($\mu\text{g}/\text{m}^3$)		% of Assessment Criteria	
	Annual Mean	1-hour Mean	Annual Mean	1-hour Mean	Annual Mean	1-hour Mean
Arsenic (as As)	<0.0001	0.0002	0.006	-	0.3%	-
Acetaldehyde (Ethanal)	<0.0001	0.0001	370	9200	<0.0001%	<0.0001%
Formaldehyde (Methanal)	<0.0001	<0.0001	5	100	0.0001%	<0.0001%
Vinyl chloride (or Chloroethylene)	<0.0001	0.0002	10	1,300 ^a	0.0001%	<0.0001%
1,3-butadiene	<0.0001	0.0001	2.25	-	0.0005%	-
Methanethiol	0.0001	0.0006	760	-	<0.0001%	-
Chloroethane	<0.0001	0.0002	6,700	No Hazard Identified	<0.0001%	-
1-pentene	<0.0001	0.0003	No Hazard Identified		-	-
1,4-epoxy-1,3-butadiene (Furan)	<0.0001	0.0002	No toxicological summary available		-	-
Ethanethiol	0.0001	0.0008	1,960	No Hazard Identified	<0.0001%	-
1,1-dichloroethene	<0.0001	0.0001	32	No Threshold Derived	<0.0001%	-
Dimethyl sulphide	<0.0001	0.0003	2,170	No Hazard Identified	<0.0001%	-
Dichloromethane	<0.0001	0.0002	44,000	No Hazard Identified	<0.0001%	-
Carbon disulphide	<0.0001	0.0002	1,880	No Hazard Identified	<0.0001%	-
1,2-dichloroethene	<0.0001	0.0002	198,000	No Threshold Derived	<0.0001%	-
1,1-dichloroethane	<0.0001	0.0001	4,000	-	<0.0001%	-

Pollutant	Maximum Process Contribution ($\mu\text{g}/\text{m}^3$)		Assessment Criteria ($\mu\text{g}/\text{m}^3$)		% of Assessment Criteria	
	Annual Mean	1-hour Mean	Annual Mean	1-hour Mean	Annual Mean	1-hour Mean
Propane-2-thiol	0.0001	0.0007	1,310	-	<0.0001%	-
1,2-dichloroethane	<0.0001	0.0001	3	-	0.0004%	-
Carbon tetrachloride	<0.0001	0.0002	130	3,900	<0.0001%	<0.0001%
Benzene	0.0001	0.0011	5	30 ^a	0.0021%	0.0038%
Trichloroethene	<0.0001	0.0002	2	-	0.0007%	-
Butanethiol	0.0001	0.0009	15	-	0.0005%	-
Dimethyl disulphide	0.0001	0.0016	380	3,800	<0.0001%	<0.0001%
Toluene	0.0007	0.0077	1,910	8,000	<0.0001%	0.0001%
Butyric acid	<0.0001	0.0002	9,150	No Hazard Identified	<0.0001%	-
Ethyl butyrate	<0.0001	0.0003	7,400	No Threshold Derived	<0.0001%	-
2-Butoxyethanol	<0.0001	0.0003	59,000	426,000	<0.0001%	<0.0001%
Styrene	<0.0001	0.0001	800	800	<0.0001%	<0.0001%
Hydrogen sulphide	0.0426	0.4562	140	150	0.03%	0.3%

- 5.10 The above confirms that each of the trace components of landfill gas will contribute a very small amount to concentrations of each of the 29 priority trace pollutants considered, equivalent to significantly less than 1% of the long-term (annual) assessment criteria and 10% of the short-term criteria. As the process contributions do not contribute more than 1%, contours have not been presented.
- 5.11 The contributions are thus considered insignificant under EA guidance. It is therefore not necessary to calculate the PEC for any of the trace gas pollutants.

6 Conclusions

- 6.1 The potential impacts associated with emissions of nitrogen dioxide from a landfill gas engine and flare, and the emissions of trace landfill gas components from the engine, flare and surface emissions, from Fair Oak landfill have been predicted.
- 6.2 Contributions of 29 priority trace landfill gas components have been predicted within the site boundary of the proposed general industrial development to the north of the landfill and compared to appropriate assessment levels. All contributions are very small in relation to the assessment levels, being well below 1% and 10% of the long-term and short-term assessment levels respectively.
- 6.3 For nitrogen dioxide, annual mean process contributions exceed 1% and 1-hour mean process contributions exceed 10% across the proposed development site; however, total concentrations, for both averaging periods, will remain well below the relevant assessment level.
- 6.4 Taking into account the worst-case assumptions, it is considered that the predicted contributions presented in this assessment are over-estimates. Furthermore, adopting AQOs and EALs that are not applicable for assessing workplace exposure introduces another layer of conservatism.
- 6.5 Overall, it is judged that the potential emissions of trace components and nitrogen dioxide from the neighbouring Fair Oak landfill site will not give rise to any significant air quality effects within the proposed development site boundary.

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8 Glossary

AAD	Ambient Air Directive
ADMS-5	Atmospheric Dispersion Modelling System model for point sources
AQC	Air Quality Consultants
AQAL	Air Quality Assessment Level
AQMA	Air Quality Management Area
AQO	Air Quality Objective
AQS	Air Quality Strategy
AURN	Automatic Urban and Rural Network
BAT	Best Available Technique
Defra	Department for Environment, Food and Rural Affairs
DNEL	Derived No Effect Level
EA	Environment Agency
EAL	Environmental Assessment Level
EBC	Eastleigh Borough Council
ECHA	European Chemicals Agency
EPUK	Environmental Protection UK
EU	European Union
Exceedance	A period of time when the concentration of a pollutant is greater than the appropriate air quality objective. This applies to specified locations with relevant exposure
HDV	Heavy Duty Vehicle
HMSO	Her Majesty's Stationery Office
IAQM	Institute of Air Quality Management
JAQU	Joint Air Quality Unit
LAQM	Local Air Quality Management
LDV	Light Duty Vehicle
µg/m³	Microgrammes per cubic metre
NO₂	Nitrogen Dioxide
NPPF	National Planning Policy Framework

Objectives	A nationally defined set of health-based concentrations for nine pollutants, seven of which are incorporated in Regulations, setting out the extent to which the standards should be achieved by a defined date. There are also vegetation-based objectives for sulphur dioxide and nitrogen oxides
PC	Process Contribution
PEC	Predicted Environmental Concentration
PEL	Permissible Exposure Limit
PPG	Planning Practice Guidance
Standards	A nationally defined set of concentrations for nine pollutants below which health effects do not occur or are minimal
TWA	Time-weighted Average
VOC	Volatile Organic Compound
WEL	Workplace Exposure Limit

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A1 Compositional Analysis



4251

ANALYSIS OF THE TRACE LANDFILL GAS

AT

Fair Oak Landfill Site

Mortimers Lane

Fair Oak

East Horton

SO50 7EA

Commissioned by: Paul Hart

Of

SUEZ Recycling and Recovery UK Ltd

Packington House,

Packington Lane,

Packington, Meriden,

Warwickshire

CV7 7HN

Date of Survey:

4th & 16th March 2021

Compiled By:

Yu Shen

Senior Project Manager



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Date of Survey: 4th & 16th March 2021

Compiled By: Yu Shen
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MCerts Level II (TE1, 2, 3 & 4)

Signed:



Dated: 29th March 2021

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3. SAMPLING PROCEDURES
4. RESULTS

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APPENDIX C: Trace Gas Chart
APPENDIX D: Siloxane Results

Notes to Report.

- a). EnviroDat Ltd, Report Template V10.
- b). This report should not be reproduced except in full, without written approval of Envirodat Ltd.
- c). Opinions and Interpretations herein are outside the scope of UKAS/MCerts Accreditation.

1. INTRODUCTION

- 1.1 EnviroDat Limited was commissioned by Mr Paul Hart, on behalf of SUEZ Recycling and Recovery UK Ltd, to measure the trace gas components and siloxanes from the landfill gas located at Fair Oak Landfill Site. Sampling was performed on the 4th & 16th March 2021.
- 1.2 The sampling was conducted in response to permit requirements (Permit No. BK1244IA). Monitoring was conducted with reference to the Environment Agency document 'Guidance for Monitoring Trace Components in Landfill Gas' (LFTGN 04). The siloxane compounds are not required under the permit but were requested by Suez R&R UK Ltd for internal information.

2. PLANT DESCRIPTION

- 2.1 Landfill gas is currently utilised by the engine plant. Samples of the fuel gas were taken from a feed system for trace gas analysis before the carbon filter.

3. SAMPLING PROCEDURES

- 3.1 Trace gas sampling was performed from the fuel gas inlet, with analysis for components identified in Table 1.1 of the EA LFTGN04 guidance note. General site information is presented in Appendix A.
- 3.2 Mixed bed, automated thermal desorption (ATD) tubes were used for sampling of the priority volatile organic species prior to analysis by gas chromatography with mass spectrometry (GC/MS), in accordance with EA recommendations and

documented EnviroDat protocol, SPTGN04. The results are presented in Appendix B. The analytical component of the work was conducted at Marchwood Scientific Services Ltd (MSS), Manchester.

- 3.3 The LFTGN04 designated 'priority' carbonyl components (i.e. methanal and ethanal) were sampled onto dinitrophenylhydrazine (DNPH) impregnated, silica gel sorbent tubes prior to analysis by high performance liquid chromatography (HPLC) incorporating an ultraviolet (UV) detection system, in accordance with EA recommendations and SPTGN04. The results are presented in Appendix B. The analytical component of the work was conducted at MSS Ltd, Manchester.
- 3.4 Arsenic was sampled onto an activated charcoal sorbent tube prior to analysis by inductively coupled plasma/optical emission spectrometry (ICP/OES), in accordance with EA recommendations and SPTGN04. The results are presented in Appendix B. The analytical component of the work was conducted at MSS Ltd, Manchester.
- 3.5 Hydrogen sulphide was analysed on site by Certified Envirodat Geotech 5000. The results are presented in Appendix B.
- 3.6 Siloxanes sampling was affected using EnviroDat Ltd. documented internal protocol SP SILOX. This involves passing a metered volume of the gas through solid sorbent material whereby the siloxane congeners are captured and concentrated to allow analysis by gas chromatography utilising mass spectrometric detection (GC/MS). The analysis was carried out at MSS Ltd, Manchester. The results are presented in Appendix D.

4. RESULTS

- 4.1 Field measurements of the 'bulk gases' are given in Appendix A.
- 4.2 Measured concentrations of the EA 'priority' trace components for the landfill gas are given in Appendix B and shown graphically in Appendix C.
- 4.3 Measured concentrations of the siloxane components for the landfill gas are given in Appendix D.

APPENDIX A

Site Information & Preliminary Gas Measurements

TABLE A1: Site Information & Preliminary Gas Measurements

Sample Position Details			
Date	04/03/2021	Site	Suez Fair Oak
Ambient Temperature	8.5°C	Atmospheric Pressure	1021mbar
Monitoring Organisation (s)	EnviroDat Ltd	Analytical Laboratory	MSS Ltd
Location of Sampling Point	Pre-Carbon Filter	Area of Influence of collection system sampled	All capped areas of the site
Type of Sampling Point	Nipple & valve	Temperature of gas	9.1°C at sample flow meter
Vacuum on Sampling	-38.55mbar	Type of waste	Domestic, Industrial, Commercial & Hazardous
		Age of Waste	-
Status of Gas System	Fully Operational, Steady State	Other	-
Parameter	Concentration	Units	Comments
Methane*	49.1	%	-
Carbon Dioxide*	36.2	%	-
Oxygen*	0.2	%	-
Nitrogen	14.5	%	Assumed to be balance of gas
Hydrogen Sulphide*	150	ppm	-

Notes: *Raw result obtained from Envirodat landfill gas analyser.

TABLE A2: Site Information & Preliminary Gas Measurements

Sample Position Details			
Date	16/03/2021	Site	Suez Fair Oak
Ambient Temperature	14.5°C	Atmospheric Pressure	1024mbar
Monitoring Organisation (s)	EnviroDat Ltd	Analytical Laboratory	MSS Ltd
Location of Sampling Point	Pre-Carbon Filter	Area of Influence of collection system sampled	All capped areas of the site
Type of Sampling Point	Nipple & valve	Temperature of gas	12.1°C at sample flow meter
Vacuum on Sampling	-38.55mbar	Type of waste	Domestic, Industrial, Commercial & Hazardous
		Age of Waste	-
Status of Gas System	Fully Operational, Steady State	Other	-
Parameter	Concentration	Units	Comments
Methane*	43.3	%	-
Carbon Dioxide*	35.2	%	-
Oxygen*	0.7	%	-
Nitrogen	20.8	%	Assumed to be balance of gas
Hydrogen Sulphide*	152	ppm	-

Notes: *Raw result obtained from Envirodat landfill gas analyser.

APPENDIX B

Trace Gas Results

TABLE B: Trace Gas Results

Trace Gases - Test 1							
	Test Duration	Flow Rate	Flowmeter	Volume	Ambient T	Barometric P	Volume
	(min)	(ml/min)	CAL Factor	(l as sampled)	(°C)	(kPa)	(l @ STP)
Arsenic	60	200	0.9977	11.97	8.5	102	11.69
Aldehydes	24	200	0.9977	4.79	8.5	102	4.68
VOC	5	50	0.9964	0.25	14.5	102.4	0.24
Compound	Mass of TG (ng)	LoD of TG (ng)	Concentration		Units	Analysis Notes (See below)	Analysis UKAS Accredited (Y/N)
Arsenic (as As)		500	< 43		µg/m3	-	N
Acetaldehyde (Ethanal)		100	< 21		µg/m3	-	Y
Formaldehyde (Methanal)	100	100	21		µg/m3	-	Y
Vinyl chloride		10	< 42		µg/m3	-	N
1,3-butadiene		10	< 42		µg/m3	-	N
Methanethiol		50	< 209		µg/m3	-	N
Chloroethane		10	< 42		µg/m3	-	N
1-pentene		20	< 84		µg/m3	-	N
1,4-epoxy-1,3-butadiene (Furan)		10	< 42		µg/m3	-	N
Ethanethiol		50	< 209		µg/m3	-	N
1,1-dichloroethene		5	< 21		µg/m3	-	N
Dimethyl sulphide	20	10	84		µg/m3	-	N
Dichloromethane		10	< 42		µg/m3	-	N
Carbon disulphide		10	< 42		µg/m3	-	N
1,2-dichloroethene (trans + cis)		10	< 42		µg/m3	-	N
1,1-dichloroethane		5	< 21		µg/m3	-	N
Propanethiol		40	< 167		µg/m3	-	N
1,2-dichloroethane		5	< 21		µg/m3	-	N
Carbon tetrachloride		5	< 21		µg/m3	-	N
Benzene	59	1	247		µg/m3	-	N
Trichloroethylene		5	< 21		µg/m3	-	N
Butanethiol		40	< 167		µg/m3	-	N
Dimethyl disulphide	69	10	289		µg/m3	-	N
Toluene	340	5	1422		µg/m3	-	N
Butyric acid		10	< 42		µg/m3	-	N
Ethyl butyrate		10	< 42		µg/m3	-	N
2-Butoxyethanol		10	< 42		µg/m3	-	N
Styrene		5	< 21		µg/m3	-	N
Compound	Concentration in ppm	LOD of TG (ppm)	Concentration		Units	Analysis Notes (See below)	Analysis UKAS Accredited (Y/N)
Hydrogen sulphide*	150	10	227679		µg/m3	-	N

*H2S value is equivalent to 150 ppm, values in highlighted box are expressed as ppm and not ng

(a) – Results have been blank corrected
(b) – Results should be considered a minimum due to detector saturation
(c) – Results should be viewed with caution due to being outside of the instrument calibration range

Reference to UKAS (final column) relates to the accreditation status of the analysis only, sampling is covered under EnviroDat Accreditation scope.

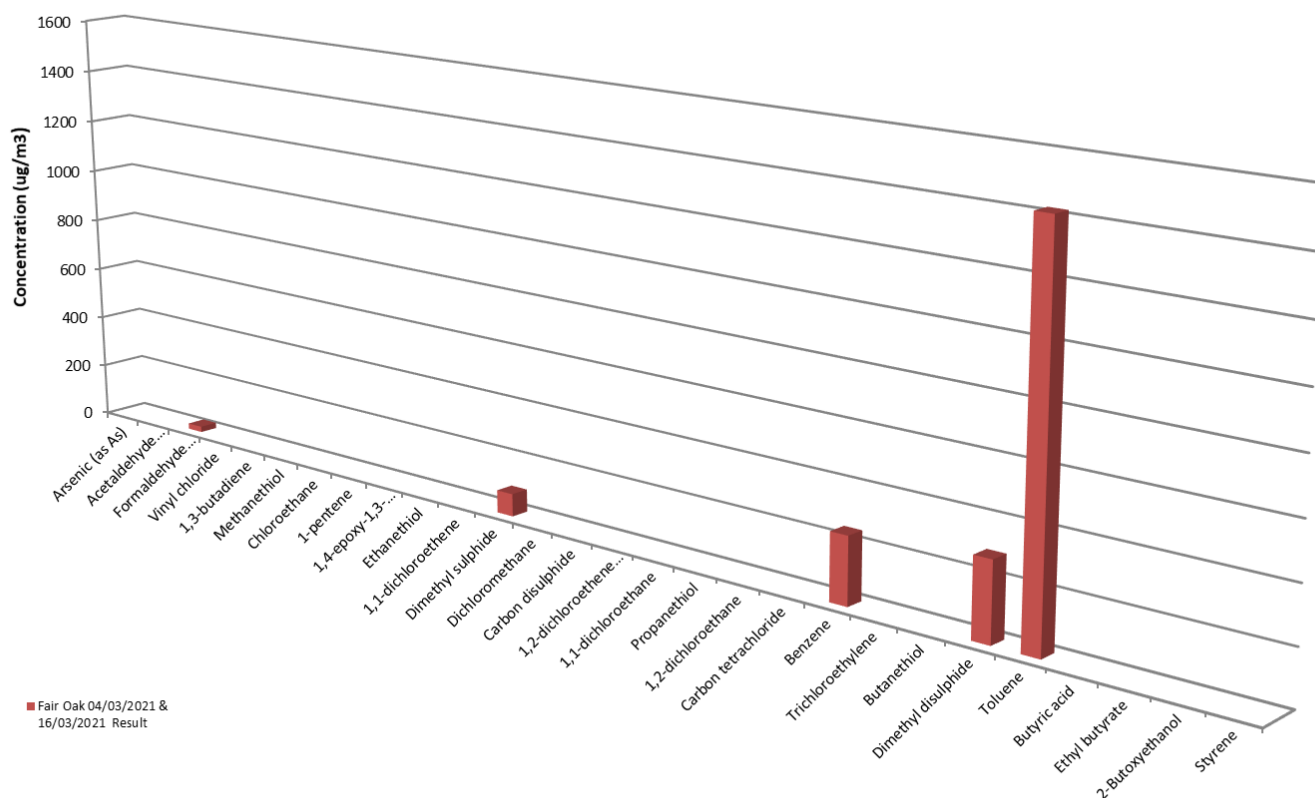
APPENDIX C

Trace Gas Chart

TABLE C: Trace Gas Chart

Priority Trace Components - Fair Oak - 2021

NON DETECTED DATA PRESENTED AS BLANKS - HYDROGEN SULPHIDE RESULTS NOT SHOWN DUE TO RELATIVELY HIGH VALUES



APPENDIX D

Siloxane Results

TABLE D(i): Siloxane Results

Test No	✓	Siloxanes
Date	✓	04/03/2021
Site	✓	Suez - Fair Oak
Stack	✓	Fuel Line
Reference Conditions - Oxygen (%)	✓	n/a
- Temperature (°C)		0
- Pressure (kPa)		101.3
Job Number	✓	R21138
Site Team	✓	YS + DVG
Test Conducted By	✓	DVG
Data Entered By	✓	YS

Test Start Time	✓	10:53
Test End Time	✓	11:13
Test Duration (min)		20
Flowmeter Rate at Start (ml/min)	✓	200
Flowmeter Rate at End (ml/min)	✓	200
Mean Flowmeter Rate (ml/min)		200
Uncorrected Volume Sampled (l)		4.00

Barometric Pressure (kPa)	✓	102.1
Ambient Temperature (°C)	✓	8.5
Flowmeter Calibration Factor (f)	✓	0.9977
Stack Oxygen Level (%)	✓	n/a
Volume Sampled @ Reference Conditions		3.90

Primary Tube Reference Identification Number	✓	849 108 7203
Security Tube Reference Identification Number	✓	849 108 7204
Blank Tube Reference Identification Numbers	✓	849 108 7205 & 849 108 7202
Mass of Siloxane on Primary Tube (ug)	< ✓	4
Mass of Siloxane on Security Tube (ug)	< ✓	4
Breakthrough (Reject if > 5%)	✓	Accepted
Total Mass of Siloxane in Sample (ug)	<	8

Siloxane Concentration (mg/m ³ @ STP and Ref O ₂)	<	2.05
--	---	------

TABLE D(ii): Siloxane/Silicon Congener Breakdown

Siloxane	Siloxane Concentration (mg/m ³ @ STP)	Organic Silicon Concentration (mg/m ³ @ STP)
Decamethylcyclopentasiloxane	< 0.26	< 0.10
Decamethyltetrasiloxane	< 0.26	< 0.09
Hexamethylcyclotrisiloxane	< 0.26	< 0.10
Hexamethyldisiloxane	< 0.26	< 0.09
Octamethylcyclotetrasiloxane	< 0.26	< 0.10
Octamethyltrisiloxane	< 0.26	< 0.09
Dodecamethylcyclohexasiloxane	< 0.26	< 0.10
Dodecamethylpentasiloxane	< 0.26	< 0.09
Total Siloxane Concentration:	2.05	
Total Silicon Concentration:		0.76

A2 Modelling Methodology

Model Inputs

A2.1 Model input selections are summarised in Table A2.1, and, where considered necessary, discussed further below.

Table A2.1: Summary of Model Inputs

Model Parameter	Value Used
Terrain Effects Modelled?	No
Variable Surface Roughness File Used?	Yes – 12km x 12km Cartesian grid at 50m resolution
Urban Canopy Flow Used?	No
Building Downwash Effects Modelled?	Yes
Meteorological Monitoring Site	Southampton Airport
Meteorological Data Years	2015 - 2019
Dispersion Site Surface Roughness Length (m)	N/A (variable surface roughness file used)
Dispersion Site Minimum MO Length (m)	10
Met Site Surface Roughness Length (m)	0.2
Met Site Surface Minimum MO Length (m)	30

Point Source Release Conditions

A2.2 Plant specific release conditions input into the model for the landfill gas engine and flare have been determined using the data set out in the technical data sheet for the Jenbacher J312 gas engine and the Technical Manual for the Uniflare 750 Nm³/hr ground flare, as provided by SUEZ. Although emissions monitoring is undertaken on these release points, the monitoring reports only report the monitored emission concentrations, not other process parameters such as volumetric flow rate and temperature. The model input parameters used for this assessment are set out in Table A2.2. Exhaust diameters and heights of release for the landfill engine and flare have been taken from drawings provided by SUEZ.

Table A2.2: Plant Specifications and Modelled Release Conditions

Parameter	Value
Jenbacher J312	
Exhaust Internal Diameter (m)	0.35
Height of Release (m)	7.8
Calculated Actual Exhaust Volume Flow (m ³ /s)	1.96
Calculated Exit Velocity (m/s)	20.4
Specified Exhaust Temperature (°C)	450
Uniflare Flare	
Flare Internal Diameter (m)	1.6
Height of Release (m)	7.73
Calculated Actual Exhaust Volume Flow (m ³ /s)	10.77
Calculated Exit Velocity (m/s)	5.36
Specified Exhaust Temperature (°C)	1,000

Emission Parameters

Trace Gases

- A2.3 Emissions monitoring performed on the landfill gas engine and flare only quantifies the total concentration of volatile organic compounds (VOCs) and does not provide speciated emissions data. Consequently, emission rates of unburnt organic trace gas components in the landfill gas engine and flare emissions have been calculated from the total VOC emission rate and the mass fraction of the individual component in the VOC (including methane) fraction of the landfill gas, as determined by the bulk and trace gas data. Emission rates of the non-VOC components, such as arsenic and hydrogen sulphide, are determined by scaling by the fractional concentration of these components in the landfill gas relative to methane.
- A2.4 An inherent assumption with this approach is that the total VOC emission only includes unburnt components of the landfill gas and that the destruction efficiency of each individual component is consistent. Due to the potential uncertainty associated with this assumption, the permit emission limit value for total VOC emissions has been used to derive the total VOC emission rate in preference to the monitored result. The monitored total VOC emission concentration is only 40% of the emission limit value, so this approach does allow an element of conservatism to be introduced.
- A2.5 With respect to the surface emissions, these have been modelled as an area source within ADMS with a uniform emission rate across the entire landfill area. The low spatial variability of results from the walkover survey (Appendix A3) support this uniform approach. The site walkover survey only provides near surface concentrations of methane and does not quantify the rate at which landfill gas

is emitted through the surface. In the absence of flux box monitoring data, surface emission rates have been estimated from the emission standard for permanently capped landfills in LFTGN07 using the approach detailed below.

- A2.6 The emission standard is expressed in terms of milligrams of methane per square metre per second (mg/m²/s). The bulk and trace gas sampling data provided by SUEZ is used to convert this to a total landfill gas equivalent based on the methane content of the landfill gas. The mass fraction of the individual components in the landfill gas is then applied to the surface emission rate of landfill gas to calculate an area emission rate for that specific compound. This is described by the equation below:

$$E_i = \frac{E_{\text{methane}}}{f_{\text{methane}}} \cdot f_i$$

Where:

E_i = surface emission rate of the i^{th} trace gas species (mg/m²/s)

E_{methane} = methane surface emission standard (mg/m²/s)

f_{methane} = fractional mass concentration of methane in the landfill gas

f_i = fractional mass concentration of the i^{th} trace gas species.

- A2.7 Finally, the area emission rate units are converted from mg/m²/s to g/m²/s for input to the dispersion model. The bulk and trace gas composition data are provided in Appendix A1.

- A2.8 The emission rates used in the model are presented in Table A2.3.

Table A2.3: Modelled Emissions

Pollutant	Engine Emission Rate (g/s)	Flare Emission Rate (g/s)	Surface Emission Rate (g/m ² /s)
Arsenic (as As)	4.88 x 10 ⁻⁰⁷	8.82 x 10 ⁻⁰⁹	1.36 x 10 ⁻¹³
Acetaldehyde (Ethanal)	1.40 x 10 ⁻⁰⁷	2.53 x 10 ⁻⁰⁹	6.67 x 10 ⁻¹⁴
Formaldehyde (Methanal)	1.05 x 10 ⁻⁰⁷	1.90 x 10 ⁻⁰⁹	6.67 x 10 ⁻¹⁴
Vinyl chloride	3.98 x 10 ⁻⁰⁷	7.18 x 10 ⁻⁰⁹	1.33 x 10 ⁻¹³
1,3-butadiene	3.44 x 10 ⁻⁰⁷	6.22 x 10 ⁻⁰⁹	1.33 x 10 ⁻¹³
Methanethiol	1.52 x 10 ⁻⁰⁶	2.75 x 10 ⁻⁰⁹	6.63 x 10 ⁻¹³
Chloroethane	4.11 x 10 ⁻⁰⁷	7.42 x 10 ⁻⁰⁹	1.33 x 10 ⁻¹³
1-pentene	8.93 x 10 ⁻⁰⁷	1.61 x 10 ⁻⁰⁸	2.67 x 10 ⁻¹³
1,4-epoxy-1,3-butadiene (Furan)	4.33 x 10 ⁻⁰⁷	7.83 x 10 ⁻⁰⁹	1.33 x 10 ⁻¹³
Ethanethiol	1.97 x 10 ⁻⁰⁶	3.55 x 10 ⁻⁰⁸	6.63 x 10 ⁻¹³
1,1-dichloroethene	3.09 x 10 ⁻⁰⁶	5.57 x 10 ⁻⁰⁹	6.67 x 10 ⁻¹⁴

Dimethyl sulphide	7.91×10^{-07}	1.43×10^{-08}	2.67×10^{-13}
Dichloromethane	5.41×10^{-07}	9.76×10^{-09}	1.33×10^{-13}
Carbon disulphide	4.85×10^{-07}	8.75×10^{-09}	1.33×10^{-13}
1,2-dichloroethene	6.17×10^{-07}	1.11×10^{-08}	1.33×10^{-13}
1,1-dichloroethane	3.15×10^{-07}	5.69×10^{-09}	6.67×10^{-14}
Propanethiol	1.93×10^{-06}	3.48×10^{-08}	5.30×10^{-13}
1,2-dichloroethane	3.15×10^{-07}	5.69×10^{-09}	6.67×10^{-14}
Carbon tetrachloride	4.90×10^{-07}	8.84×10^{-09}	6.67×10^{-14}
Benzene	2.92×10^{-06}	5.28×10^{-08}	7.84×10^{-13}
Trichloroethylene	4.18×10^{-07}	7.55×10^{-09}	6.67×10^{-14}
Butanethiol	2.28×10^{-06}	4.12×10^{-08}	5.30×10^{-13}
Dimethyl disulphide	4.13×10^{-06}	7.45×10^{-08}	9.17×10^{-13}
Toluene	1.99×10^{-05}	3.59×10^{-07}	4.51×10^{-12}
Butyric acid	5.61×10^{-07}	1.01×10^{-08}	1.33×10^{-13}
Ethyl butyrate	7.40×10^{-07}	1.34×10^{-08}	1.33×10^{-13}
2-Butoxyethanol	7.52×10^{-07}	1.36×10^{-08}	1.33×10^{-13}
Styrene	3.32×10^{-07}	5.99×10^{-09}	6.67×10^{-14}
Hydrogen sulphide	1.18×10^{-03}	2.13×10^{-05}	7.23×10^{-10}

NO_x

A2.9 The NO_x emissions concentrations data input into the model for the landfill gas engine and flare have been derived from the technical datasheets and manuals provided by SUEZ. The emissions concentration and emission rate are provided in Table A2.4.

Table A2.4: Modelled NO_x Emissions

Value	Engine	Flare
NO _x Emission Concentration (mg/Nm ³)	500 ^a	150 ^b
NO _x Emission Rate (g/s)	0.287	0.155

^a At 0 °C, 101.325 kPa, 5% oxygen, dry.

^b At 0 °C, 101.325 kPa, 3% oxygen, dry.

Spatial Configuration

- A2.10 The physical parameters for the point sources included in the modelling are outlined in Table A2.5. The surface emissions have been included in the model as an area source covering the full extent of the landfill site boundary shown in Figure 1.

Table A2.5: Modelled Physical Release Emission Parameters for the Plant

Parameter	Modelled Release Parameters	
	Gas Engine	Flare
Source Type	Point	
X-Coordinate	450600.9	450594.0
Y-Coordinate	118443.9	118436.2
Height above Ground (m)	7.8	7.725

Buildings

- A2.11 Entrainment of the plume into the wake of the proposed residential buildings (the so-called building downwash effect) has been taken into account by including buildings located within five stack heights (approximately 40 m) of the stacks in the model. The modelled building layout is shown in Figure A2.1.

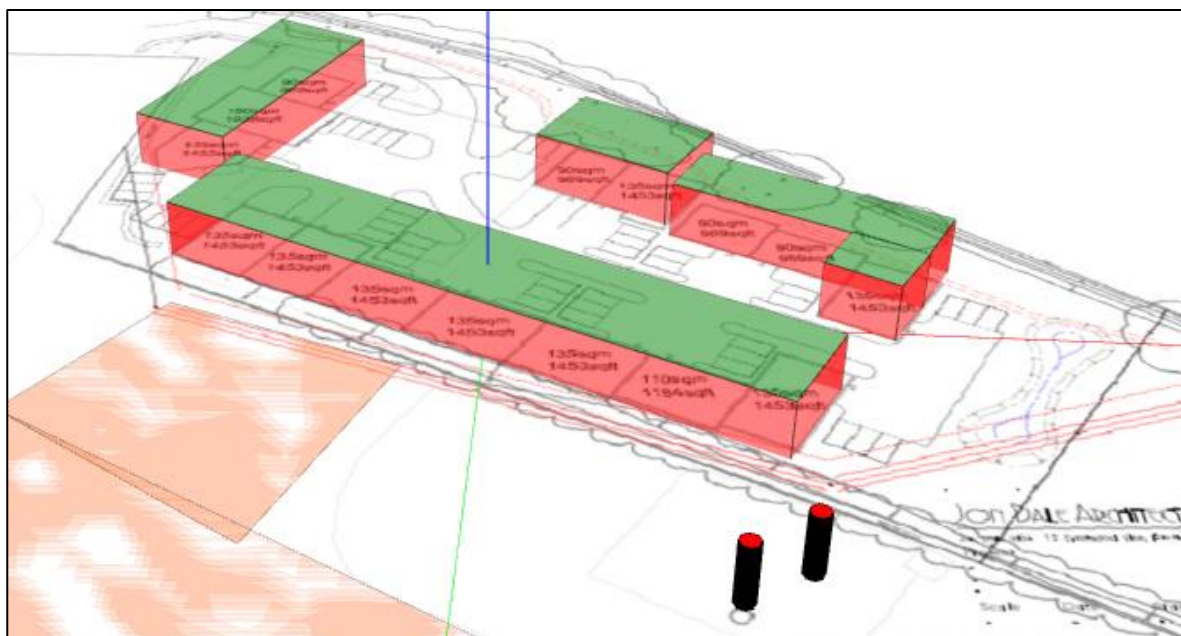


Figure A2.1: Flue Locations & Modelled Buildings

Includes data from John Dale Architect Limited, drawing reference JD_116_SL01.

Variable Surface Roughness File

A2.12 The area surrounding the site encompasses a range of land types. A variable surface roughness file has been used to represent the spatial variation of the surface roughness over each land type (Figure A2.2). The following parameters have been used in creating this file:

- forest – 1 m;
- built-up area – 0.5 m;
- grassland – 0.3 m; and
- water – 0.0001 m.

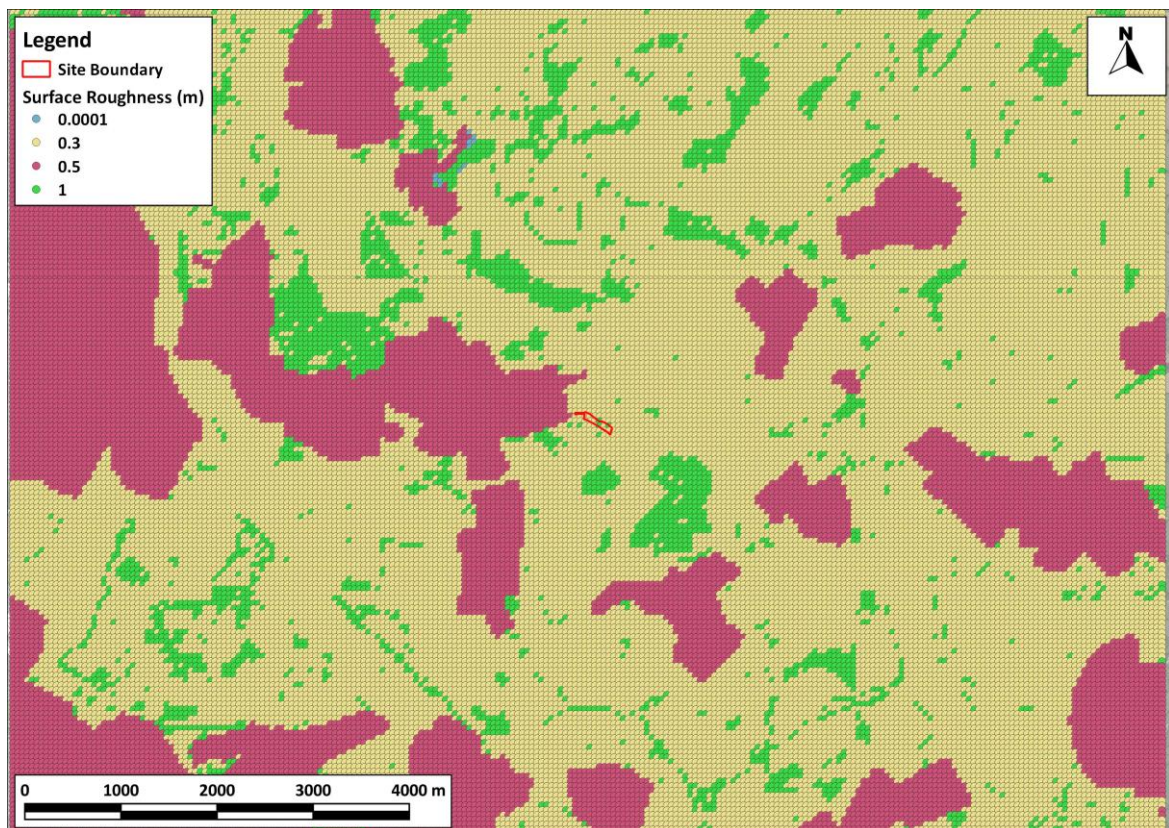


Figure A2.2: Surface Roughness Parameters

Meteorological Data

A2.13 Hourly sequential meteorological data from Southampton Airport for 2015-2019 have been used in the model.

A2.14 The Southampton Airport meteorological monitoring station is located approximately 6 km to the southwest of the proposed development site. It is deemed to be the nearest monitoring station representative of meteorological conditions at the proposed development site; both the development

site and the Southampton Airport meteorological monitoring station are located in the south of England where they will be influenced by the effects of inland meteorology in flat-lying topography.

- A2.15 Raw data were provided by the Met Office and processed by AQC for use in ADMS. Wind roses for the site for the years 2015-2019 are provided in Figure A2.3.

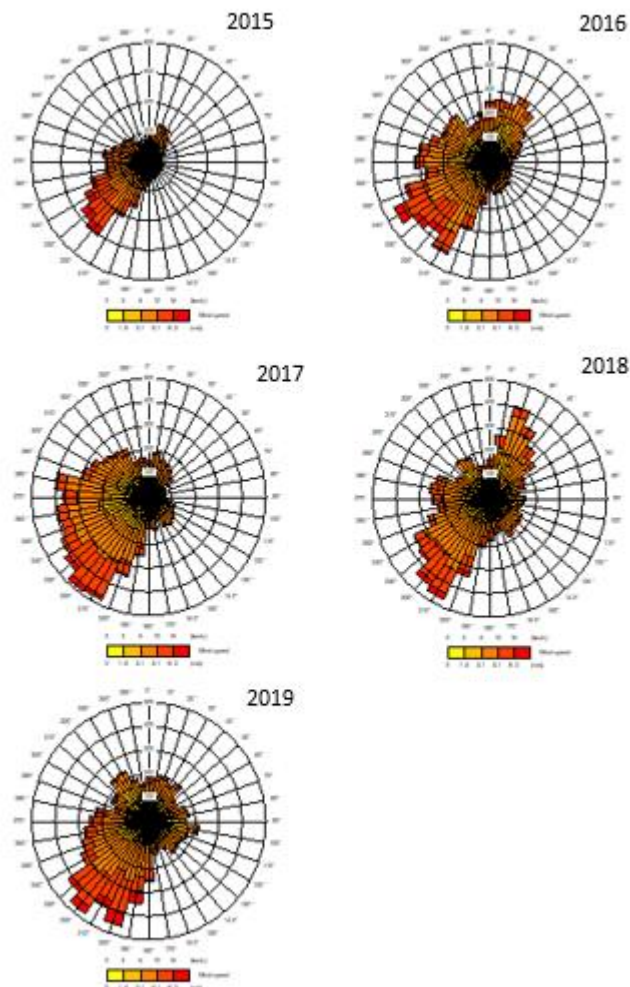


Figure A2.3: Wind Roses

Model Post-Processing

NO_x to NO₂ Conversion

- A2.16 NO_x emissions will be in the form of nitric oxide (NO) and primary NO₂. The primary is likely to be in the region of 5-12% of the total NO_x. Over time, the NO emissions will react with available ozone (O₃) to form NO₂. In close proximity to the source, the ratio will be similar to the primary NO₂

proportion; with increasing distance from the source the ratio will increase, depending on the availability of O₃.

A2.17 The EA (2016) recommends that, as a conservative approach:

- 70% of the NO_x emitted from the generators converts to NO₂ for the annual mean average concentrations; and
- 35% of the 1-hour mean NO_x emitted from the generators converts to NO₂ for the 1-hour mean average concentrations.

A2.18 The EA Guidance on dispersion modelling for oxides of nitrogen assessment from specified generators Version 1 (EA, 2018) states: *“For primary NO₂ to NO_x ratios of 10% or less, worst case NO_x to NO₂ conversion ratios of 35% for short term assessment and 70% for long term assessment can be used as a conservative approach in the modelling study.”*

A2.19 It is likely that the primary NO₂:NO_x ratio will be 10% or less; therefore, the 70% (long-term) and 35% (short-term) conversion ratios used represent a conservative approach.

Annual Mean PCs

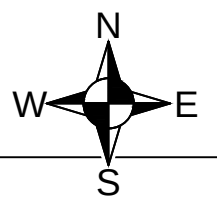
A2.20 The model has been run assuming constant operation of both the flare and engine. No adjustments have, therefore, been made to the raw model long-term outputs.

Short-term PCs

A2.21 The assessment has considered the 100th percentile of 1-hour concentrations for trace gases, which is the maximum predicted concentration in any modelled hour of the year.

A2.22 For nitrogen dioxide, the 1-hour mean assessment level is based on the number of hours (18) that a threshold concentration (200 µg/m³) can be exceeded in a year. The approach has, therefore, been to assume constant operation, and consider the 99.79th percentile of 1-hour mean concentrations, which represents the 19th highest hour from a full year (8,760 hours).

A3 Walkover Data



NOTES
1. PPC SURVEY CARRIED OUT BY SLR CONSULTING ON 30th NOVEMBER 2017.

LEGEND

BOUNDARY OF UPDATE SURVEY

SURVEY CONTROL USED

SURVEY CONTROL STATIONS			
	APPROVED SITE CONTROL	SITE SURVEYED CONTROL	DIFFERENCE
STATION	STN1	STN1	
EASTING	450431.548	450431.548	0.000
NORTHING	118015.907	118015.907	0.000
LEVEL	39.603	39.603	0.000
STATION	STN2	STN2	
EASTING	450673.227	450673.238	0.011
NORTHING	118399.816	118399.807	-0.009
LEVEL	44.135	44.141	0.006
STATION	STN4	STN4	
EASTING	450286.734	450286.741	0.007
NORTHING	118109.889	118109.875	-0.014
LEVEL	48.206	48.210	0.004

0	KH	NPS	12/17	
Revision	By	Chk'd By	Date	Comments



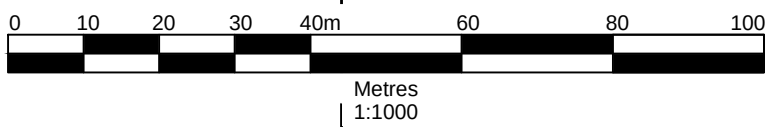
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Site
FAIROAKS LANDFILL SITE

Project
NATIONAL SURVEY CONTRACT

Drawing Title
PPC SURVEY
30TH NOVEMBER 2017

Scale 1:1000@ A1	Date NOVEMBER 2017
Drawing Number 001	Revision 0



A4 Professional Experience

Adam Clegg, BSc (Hons) MEnvSc MIAQM

Mr Clegg is a Technical Director with AQC, with over seventeen years' experience, specialising in industrial emissions. He is a member of the Institute of Air Quality Management, has previously contributed his time to, and authored publications on behalf of, the Energy Institute's Emissions Working Group, and has acted as peer reviewer for the Journal of Air & Waste Management. His expertise includes ambient and stack emissions monitoring, emission inventory development and reporting, atmospheric dispersion modelling, abatement of air emissions, environmental permitting, Best Available Technique (BAT) assessments, cost-benefit analysis and compliance assessment. He has extensive experience in the quantification and assessment of emissions from a variety of releases, covering point source emissions, flare emissions, fugitive emissions and emissions from mobile transport sources, including marine vessels, on-road and off-road vehicles and rail locomotives. He has detailed knowledge of the technologies and techniques to reduce concentrations of combustion and non-combustion related pollutants, including oxides of nitrogen, acid gases (e.g., SO₂, HF, HCl), volatile organic compounds (VOCs), particulates, heavy metals and odour.

Dr Denise Evans, BSc (Hons) PhD MEnvSc MIAQM

Dr Evans is an Associate Director with AQC, with more than 23 years' relevant experience. She has prepared air quality review and assessment reports for local authorities, and has appraised local authority air quality assessments on behalf of the UK governments, and provided support to the Review and Assessment helpdesk. She has extensive modelling experience, completing air quality and odour assessments to support applications for a variety of development sectors including residential, mixed use, urban regeneration, energy, commercial, industrial, and road schemes, assessing the effects of a range of pollutants against relevant standards for human and ecological receptors. Denise has acted as an Expert Witness and is a Member of the Institute of Air Quality Management.

Dr Frances Marshall, MSci PhD MEnvSc MIAQM

Dr Marshall is a Principal Consultant with AQC with over eight years' relevant experience. Prior to joining AQC, she spent four years carrying out postgraduate research into atmospheric aerosols at the University of Bristol. Dr Marshall has experience preparing air quality assessments for a range of projects, including residential and commercial developments, road traffic schemes, energy centres, energy from waste schemes and numerous power generation schemes. She has experience in producing air quality assessments for EIA schemes, and has also assessed the impacts of Local Plans on designated ecological areas, prepared Annual Status Reports for Local

Authorities, and undertaken diffusion tube monitoring studies. She is a Member of both the Institute of Air Quality Management and the Institution of Environmental Sciences.